THE MODEL ENGINEER

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Smoke Rings

Junior Ship Modelling

A STRIKING demonstration of the skill of the younger generation in the building of ship models was recently given during the Warships Week at Rushden, Northants, Seven schools took part in the display and over 100 miniature ship models were placed on view. The contest for prizes was organised by Mr. S. A. Lawrence, head-master of the Rushden Alfred Street School, and the judging was carried out by Mr. W. J. Bassett-Lowke and Mr. H. W. Franklin. The show raised over £10. Should any of our readers wish to arrange a similar show, I understand that the National Savings Committee of Great Smith Street, London, S.W.1, are supplying, free of charge, a series of drawings of various warships, complete with detailed instructions for their making. These are available for any educational or other organisation desiring to get an exhibition together in connection with a Warship Week.

Spare-time Munitions Work

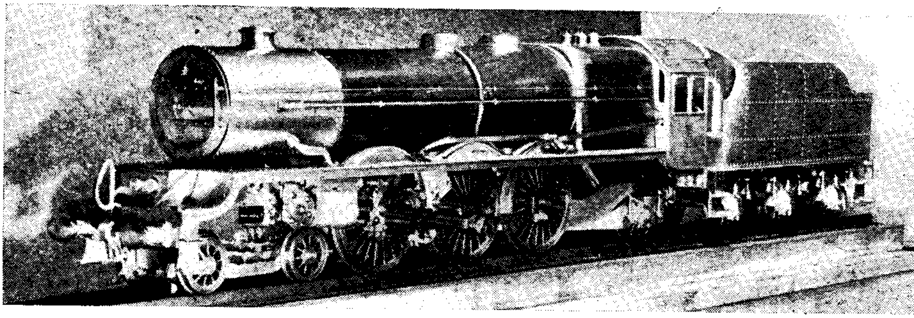
MESSRS. HOWARD TENENS, Ltd., of Bevis House, Bevis Marks, London, E.C.3, are organising a scheme under which those desirous of participating voluntarily in part-time munitions work will be enabled to join with others as voluntary night workers in a N.W. London aircraft components factory. A special appeal is made to those resident in the N.W. London area to join in an effort which is being made by a body of voluntary workers to increase the already high output. The scheme is only practicable if 12 men a night can be recruited and relied upon for one night per week. The present call is for a minimum of 72 volunteers.

Our Division-plate Competition

MR. JOHN LATTA, in acknowledging receipt of the prize awarded to him, writes :—" I would ask you to convey my thanks to Mr. Fooks and offer my congratulations on the interest his problem has aroused. I am naturally very proud to have been judged the winner, but in order that I should not be thought to take undue credit for the solution I put forward, I have looked over such works of reference as I have available in order to discover the source of my inspiration. I find that the procedure I outline is described in 'Modern Toolmaking Methods,' by Franklyn D. Jones, published in New York by the Industrial Press, 1915, and I would like to acknowledge my indebtedness to the author. Incidentally, this book also describes several other methods of achieving the same result, besides being a mine of information on tool-making practice."

Percival Marshall

Some of the ship models shown in the junior section of the "Warships Week" display at Rushden, Northants.



Mr. S. N. Green's $2\frac{1}{2}$-in. gauge "Princess Royal" before painting and first steam test.

Small Locomotive Construction

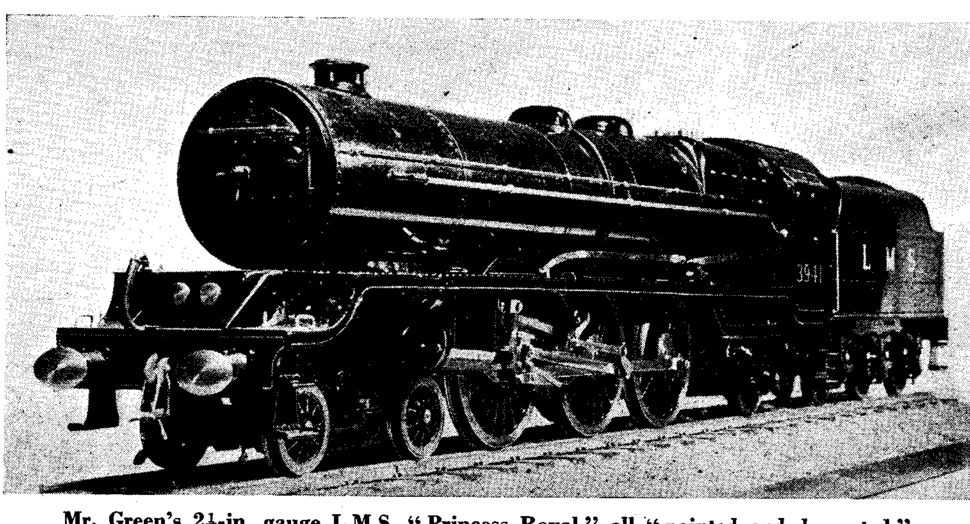
By a CANADIAN READER

WE are now publishing the promised photographs of Mr. S. N. Green's $2\frac{1}{2}$-in. gauge L.M.S. 4-6-2 engine *Princess Royal*, which, as stated in the previous article (see April 2nd, 1942, issue), replaced a partly-finished $3\frac{1}{2}$-in. gauge *Royal Scot*. Mr. Green has no place of his own in which to lay a track, and so he abandoned the idea of $3\frac{1}{2}$-in. gauge engines in favour of $2\frac{1}{2}$-in. gauge in order to take advantage of running on the $2\frac{1}{2}$-in. gauge track belonging to Mr. Roland Gissing, of Cochrane, about 30 miles away from Mr. Green's home.

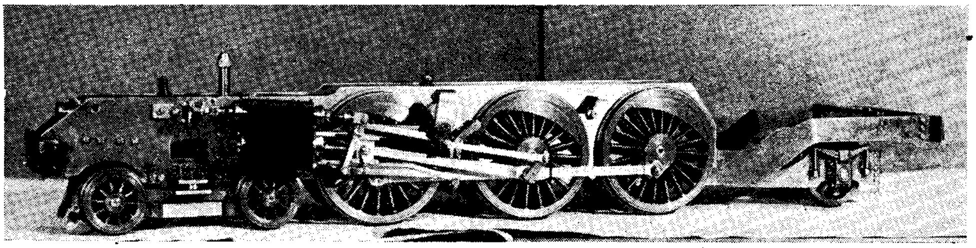
The photographs show that the *Princess Royal* is an excellent piece of work; she is built to "L.B.S.C.'s" published instructions, except for the fact that the firebox has a sloping backplate, as in the prototype, and one of the latest high-sided tenders has been provided. On test, the engine gave much satisfaction; there is plenty of power, lots of steam, and the only difficulty is to keep the safety-valves from blowing-off all the time.

The first test (see the picture on the cover of this issue) gave an excellent performance from the engine; but owing to the very poor coal available in Canada, Mr. Green has converted the firebox to take an oil-burner instead.

The number of the engine may cause surprise to some readers; but Mr. Green explains that, as the construction of the engine was begun in 1939 and finished in 1941, he decided on a system of numbering incorporating the dates mentioned—hence



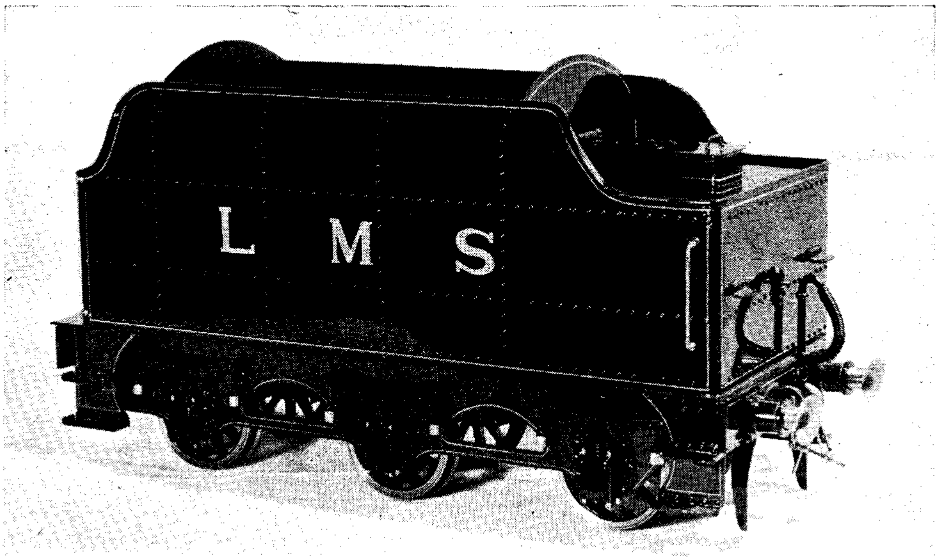
Mr. Green's $2\frac{1}{2}$-in. gauge L.M.S. "Princess Royal" all "painted and decorated."



The chassis of the $2\frac{1}{2}$-in. gauge "Princess Royal."

"3941"! This system is to be perpetuated in future models built by Mr. Green.

As in the case of the 0-6-0 tank engine described in the previous article, there can be little doubt that the workmanship in the



A view showing the fine detail work on the tender.

Princess Royal is of high quality. Further, we believe that most of the details had to be specially made, due to the difficulty of purchasing such items in Canada. A keen enthusiasm, combined with the fortunate collaboration of a fellow-enthusiast, can make molehills out of what may, perhaps, look like high mountains! We congratulate Mr. Green upon having achieved so much realism in the detail and appearance of his *Princess Royal*, no easy task in view of the fact that he has probably not yet seen any of the prototype engines, and had nothing but "L.B.S.C.'s" instructions and some published photographs to guide him.

Readers' Work Photographs

IN response to requests from time to time, asking that we should publish more photographs of other readers' work, we now invite readers to send us a photograph of any model or other interesting piece of work they have made. The following conditions should be complied with :—(1) Photos. may be of any size, but preferably not smaller than quarter-plate. Unmounted glossy prints are the most suitable for reproduction ; (2) Name and address of the sender should be written on the back of each photo. ; (3) A short description of the subject, about 100 words, should accompany each photo. ; (4) Unsuitable photographs will be returned if a stamped addressed envelope is enclosed. For each photograph selected for publication we will pay a fee of 5s. on acceptance. Entries should be addressed to the Editor of THE MODEL ENGINEER and marked "Readers' Work" on the envelope.

"L.B.S.C." on How to Set Out

A 2-to-1 Valve Gear

A FOLLOWER of these notes is rebuilding a L.N.E.R. Pacific locomotive which was originally built with two cylinders only "for the sake of simplicity" (apologies to a famous catalogue!) and proposes to add the third cylinder, but is rather perturbed about the valve gear for it. He wants to use the regulation Gresley 2-to-1 conjugation, and to that end he purchased from the offices of a contemporary journal, a blueprint of the inside valve gear of the "Green Arrow" class, made according to your humble servant's specifications and proved O.K. on the road by many builders of that particular type of locomotive; but he finds that his valve spindle centres are different from those given on the blueprint, so writes to ask what is the "formula" for getting the correct dimensions of the levers to suit his own engine.

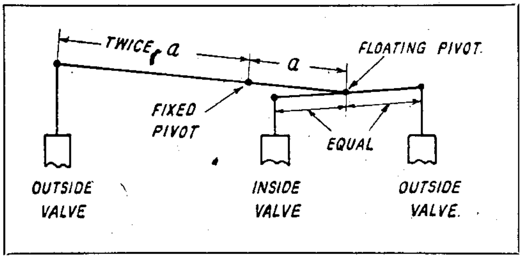


Diagram of the Gresley 2-to-1 gear

A Simple Job

There isn't any. Setting out the gear is a simple rule-of-thumb job, although, like many other things in locomotive design and construction, attempts have been made to "wrap it up in mystery," so that a "select few" can claim a special knowledge akin to that of the tribal witch-doctors we used to read about in tales of adventure in the wilds. I know of somebody who procured a pass to visit a L.N.E.R. locomotive shed, and spent nearly the whole of a Sunday morning underneath a "jazzer" in an endeavour to find out all about the conjugation, so that he could fit it to a three-cylinder "Mikado" he was building; but he couldn't see the wood for trees! The simplicity of the gear puzzled him so much that he gave it up and fitted three separate sets of valve gear to his engine.

For the benefit of new readers, the Gresley gear is a combination of two levers, pivoted and connected so that the inside valve of a three-cylinder engine can be operated from the valve spindles of the two outside valves; thus only two sets of valve gear are necessary. If all three cylinders are in line, the cranks are set at 120 deg., but if the centre cylinder is inclined, the inside crank is set to an equal angle, so that when the steam port of the inside cylinder "cracks" to lead opening, the crank is on the dead centre, in relation to the cylinder. A long lever is connected to one outside valve spindle and, at two-thirds of its length, is pivoted to a fixed point on the engine frame. A shorter lever is connected to the other outside spindle; and at the centre of its length is pivoted to the loose end of the long lever. The other end of the shorter lever is connected to the inside valve. That is all there is in the whole bag of tricks; terrible lot to make a mystery about, isn't it?

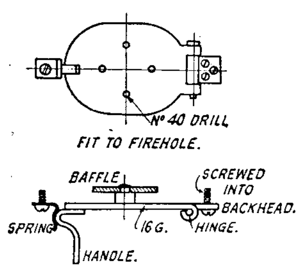
Two-to-One!

It should be obvious to anybody, that so long as the pivot of the long lever is placed two-thirds of the way along, the actual length of the lever doesn't matter a bean. If you have a lever 3 in. long, pivoted 2 in. from one end, and move the longer end $\frac{1}{2}$ in., the shorter end will move $\frac{1}{4}$ in.; and the movement of the ends would be exactly the same in a lever 3 ft. long pivoted 2 ft. from one end, or make it miles if you like! Also, the ends of a lever pivoted in the middle, will move equally, whatever the total length. Therefore, all our friend has to do in order to set out his two-to-one conjugation is to connect up his inside valve spindle to its nearest outside neighbour, by a suitable lever pivoted in the middle of its length, to a longer one, which is connected to the other outside valve spindle. Divide the longer lever into three, and at the division nearest the inside spindle pivot it to a bracket attached to the frames, as shown on the "Green Arrow" blueprint mentioned above. Set the two outside cranks at 120 deg. and the inside crank on dead centre with its own cylinder, when the port on that component just opens to lead. That is all there is to it! But followers of Inspector Meticulous will find all, and probably more than they require as to the details of this ingenious gear in a book called "Locomotive Design, Data and Formulae," by E. A. Phillipson.

"MOLLY"

Firehole Door

"Molly's" big sisters have sliding firehole doors made in two pieces, which slide in runners above and below the firehole, and are actuated by levers connected together and operated by a single handle. On "Molly junior," we are obliged to have an outsize firehole in proportion to the size of the firebox, as a "scale" firehole would be useless as a working proposition; and a correct pattern sliding-door arrangement applied to this, would not only fill the lower part of the backhead, but would run foul of the pipes and fittings. Also, I find that this type of firehole door is an unmitigated nuisance in the small sizes, as the runner at the bottom persists in getting blocked up with coal dust and the doors won't shut properly. Therefore I recommend my old tried and trusted favourite swing door,



Firehole door.

which does the doings properly, despite the ridicule cast on it by the non-building fraternity, who liken it to that on the domestic copper—which, incidentally, also fulfils its "mission in life" in perfectly satisfactory manner, which is more than can be said of certain other more complicated appliances!

A sketch of a suitable firehole door is appended, and it can be made either from a casting or built up from 1/16-in. sheet steel. In the latter case, strap hinges are not necessary; two projections are left on the back end of the door, and they are bent into loops around a piece of 16-gauge spoke wire. The end of a similar strip just wide enough to fit between them, is bent in the same way, and a pin put through the lot to form a hinge. The loose end of the hinge is attached to the backhead by three 8 B.A. brass screws fitting tapped holes in the backhead. If a smear of plumber's jointing is applied to the threads there will be no leakage. No loose catch is needed; the spring device which I fitted to the tiny "County of Rutland," and have since adopted as "standard" (blessed word that!) is far more handy on the road when you are firing the engine on the run. A handle formed from bent strip is riveted to the door and engages with a bit of flat spring steel screwed to the backhead; see sketch, which needs no further explanation.

A $\frac{3}{4}$-in. steam gauge is connected to the left-hand union on the turret, and this may be home-made as recently described. A $\frac{1}{8}$-in. pipe is taken from the right-hand union to the union on the blower valve. We can leave the whistle until the running-boards or side platforms are fitted, as it goes underneath one of them; same applies to the injector.

Smokebox

The smokeboxes on the big "Mollies" have a wrapper-sheet extending down between the frames, forming its own "saddle," and there is a circular extension projecting beyond this. After sundry brainstorms and stirrings of grey matter in an endeavour to scheme out a simple way of making a similar smokebox for the little engine, I came to the conclusion that the easiest way would be to make the entire smokebox circular, of the usual pattern, and mount it on a saddle, the upper side edges of which would be filed to knife edges; these, when painted, would be practically invisible. The advantages of having the simple circular smokebox are more than sufficient to outweigh the slight deviation from full-size practice.

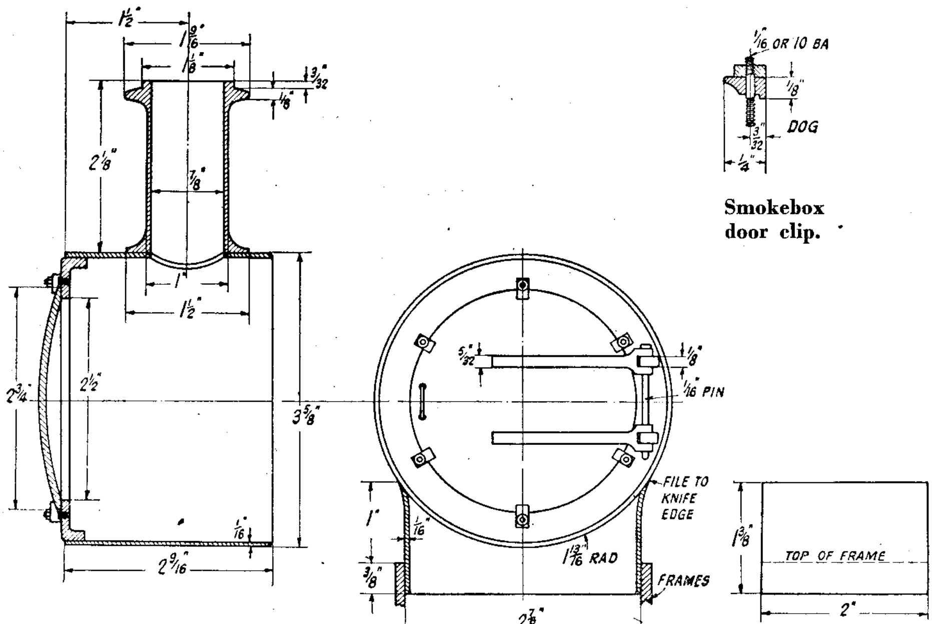
The barrel is a piece of brass, copper, or steel tube $3\frac{5}{8}$ in. outside diameter and 16 gauge, which should be a tight fit over the outside of the boiler barrel. Square it off in the lathe to a dead length of 2 9/16 in., and at the rear end round off the edge as shown in the section. At $1\frac{1}{2}$ in. from the front end, drill a $\frac{7}{8}$-in. hole for the chimney; if you haven't a drill this size, scribe a circle $\frac{7}{8}$ in. diameter, use the biggest drill you have, and finish with a file. The position of the holes in the bottom part can be got from your actual engine, in conjunction with the recently-illustrated section of the complete front end.

The front plate, or ring as it is usually called, is flanged up from a disc of $\frac{1}{8}$-in. sheet brass about $4\frac{1}{8}$ in. diameter, same way as the smokebox tubeplate of the boiler, the same former being used; but don't hit the flange into too close contact with it, as the smokebox is slightly larger in diameter. Skim up the ragged edges and turn the ring to a tight fit in the smokebox barrel, exactly as I described for the smokebox tubeplate; then chuck by the inside of the flange, and, with a parting-tool, cut out a hole $2\frac{1}{2}$ in. diameter. Face off the front very

carefully, so that the door will close air-tight, and round off the edge to a small radius as shown in the section.

The door can be made from a $2\frac{3}{4}$ in. by $\frac{1}{8}$ in. commercial brass blank, or from a disc cut from $\frac{1}{8}$-in. brass sheet. Anneal it, and dish it by laying it on a block of lead, or soft wood, and hitting it with the ball end of the hammer-head. I usually start in the middle and work outwards ; some folk say start at the outer edge and work to the middle, but so long as you get an evenly dished plate, it doesn't matter. Chuck in the three-jaw by the edge, concave side out, set to run truly, and turn a flat spot about $\frac{1}{2}$ in. diameter in the middle ; solder on this a stub end of brass rod between $\frac{1}{2}$ in. and $\frac{3}{8}$ in. diameter, which has been faced off truly. If this is then chucked in the three-jaw, the door can be completely turned at the one setting, facing off the contact edge with a left-hand knife tool. If you get a plentiful adornment of tool marks on the convex side (many amateurs do !) smooth them with a flat file and finish with emerycloth or some similar abrasive.

The hinge straps are made from 1/32-in. sheet. Cut them to the shape shown in the drawing of the smokebox front and bend the ends around a piece of 1/16-in. steel wire to form the eyes. Rivet them to the door with bits of domestic pins for rivets. The lugs can either be made from sheet strip in a similar manner, and riveted to the ring, or you can chuck a bit of $\frac{1}{8}$ in. by $\frac{1}{4}$ in. flat rod in the four-jaw, setting it to run truly, and turn a 3/32-in. spigot on the end about 3/16-in. long. Screw it 3/32 in. or 7 B.A., and part off at 7/16 in. from the end. Repeat operation, then round off the two squared sections to the shape of the lugs, and screw them into tapped holes in the smokebox ring. Tip : it is easier to get the right location of the lugs, whichever type you use, if they are attached after the dogs have been made and the door temporarily clamped in its correct position.



Smokebox door clip.

Smokebox and saddle for "Molly."

The dogs are made from six pieces of $\frac{1}{8}$-in. square rod, each $\frac{1}{4}$ in. long. File them up to the shape shown in the illustration and drill a No. 51 hole at 3/32 in. from the wide end ; this is where a small machine-vice comes in mighty handy. If you haven't one, a substitute can easily be rigged up with two short bits of angle placed back to back, and secured by a couple of bolts, with the object to be gripped placed between the angles. The studs are six 7/16-in. lengths of 1/16-in. silver-steel or 16-gauge spoke wire, screwed at both ends, and inserted into six holes drilled equidistant around the big hole in the ring, at 3/16 in. from the edge, and tapped to suit. Place the door in position, drop a dog over each stud, secure lightly with a nut, set the door central with the ring and tighten up the nuts. You will now

see exactly where the hinge lugs have to be attached; they can then be fixed, and a 1/16-in. pin put through the pair of them.

Chimney

This can be made from a casting—I believe the advertiser who has supplied the bulk of "Molly" castings has made a pattern for it—or built up. In the former case it is merely a plain turning job needing no detailing out. The easiest way to chuck it is to knock a bit of wood or metal into the end and grip in three-jaw, or else mount it on a mandrel between centres. The base is hand-finished with file and emerycloth, same way as the kids used to "machine" up the one-and-ninepenny sets of castings supplied by a long-defunct Staffordshire firm. In those days you could buy a bench lathe, of sorts, for 17/6; but the great majority of us couldn't rake up even that much!

To make a built-up chimney you want a piece of tube (brass, copper or steel, it doesn't matter which) 1 in. outside diameter and 2¼ in. long. A ring, about 1⅝ in. diameter, ⅜ in. wide, and bored to fit on the tube, is silver-soldered to one end, and a similar ring, about ½ in. wide, to the other. The tube is then mounted on a mandrel and the rings turned to form the lip and base, the latter being the wider one. Whether the chimney is cast or built up, take care to form it exactly to the given dimensions. More locomotives have been spoilt in personal appearance by an inaccurate chimney than by any other component. I guess our good friend Mr. J. N. Maskelyne will add a hearty "hear, hear!" to that.

As to the base, this can be saddled to the smokebox by machining with a flycutter. Get a piece of steel rod about ⅝ in. diameter and about 2 in. long, drill a ¼-in. cross hole ¼ in. from one end, and fit a setscrew into the end of the rod. Make a little roundnose turning tool from ¼-in. round silver-steel, and set it in the crosshole so that the cutting edge is 1 13/16 in. from centre. Grip the other end of the rod in the three-jaw. Mount the chimney, base outwards, on a bit of wood or metal, clamp under the lathe tool-holder at right-angles to lathe centres and level with them; start the lathe, and feed up with the cross slide very gingerly until the revolving tool just starts to cut the bottom of the base. Then traverse the top slide back and forth, feeding a weeny bit more into cut with the cross slide after each traverse, and the flycutter will, in due course, carve out a lovely curve in the bottom of the base, which will exactly fit the smokebox. Finish off the outside with file and emerycloth as before. The completed chimney is attached to the smokebox by four 3/32-in. countersunk screws.

Smokebox Saddle

This is a simple job; it consists of four pieces of 1/16-in. sheet steel, cut to the given dimensions and joined at the corners either by brazing or by pieces of angle riveted on. The latter may be either "regulation" drawn angle or bent up from odd scraps of the self material. Alternatively, the end-plates of the saddle may be cut a little wider than the finished width, and the surplus bent over at right-angles which fit between the sides and are riveted to them, or brazed. I usually build up my saddles by Sifbronzing the bits together, using the oxy-acetylene blowpipe with a 50-litre tip in it; and the job is actually easier than soft-soldering. To hold the parts in position I made two weeny-weeny clamps from bits of guide-bar steel, with 3/32-in. screws, and fixed one of them to each end of a short length of soft iron wire. Two adjacent plates of the saddle are held in position by gripping one in each clamp and setting the edges at right-angles to form a corner. As the clamps are joined by the wire, which is easily bent to any shape, they "stay put" and keep the plates in position. The joint is then fluxed, a spot of Sifbronze dropped in it, and the blowpipe flame applied like a soldering bit, which heats the joint to redness, and the Sifbronze melts and runs in, just like soft solder, only umpteen times as strong.

Whichever way you make the saddle, file the flared tops of each side to a knife edge, so that when the smokebox is seated on it the joint can hardly be noticed and will probably be invisible when the whole issue is erected and painted.

An Aged Locomotive

The L.M.S.R. has recently announced that engine No. 20002 is still in regular service, hale and hearty, at the age of 76 years, though her duties are not now of a very strenuous nature. She belongs to the old Midland "No. 1" class of double-framed 2-4-0 type engines with 6-ft. coupled wheels, and was originally put into traffic early in 1866. Two sister-engines, Nos. 20008 and 20012, still survive, though they are not quite so old as No. 20002. A photograph of the latter, together with a few historical notes, was published in "Railway Topics" in *The Model Railway News* for May, 1939.

*LOCOMOTIVE HEADLAMPS

(No. 6) The Great Western Railway's are dealt with this week by Mr. F. C. HAMBLETON

ONE of the most attractive things about the handsome G.W.R. locomotives is the fact that they have always exhibited features both revolutionary and conservative; that is to say, revolutionary and progressive in general design, but conservative as regards detail. Their headlamps were a case in point.

When W. Dean was appointed as chief at Swindon in 1877, he had the task of supplying both narrow and broad-gauge engines, and, prior to the complete conversion of the whole system to the narrow gauge, to design broad-gauge engines which could be later converted to run on the narrow gauge

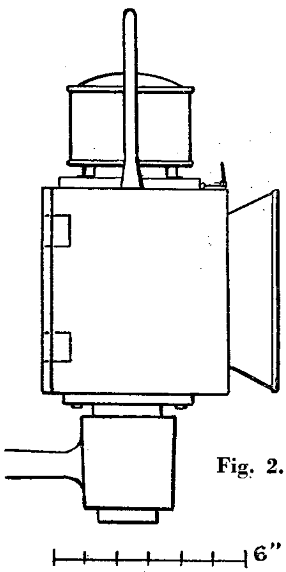


Fig. 2.

6"

track through the expedient of discarding their outside frames and shortening the axles! These and many other interesting innovations and experiments in general locomotive practice were made by him. Yet, in the matter of smaller details, Dean showed himself remarkably conservative.

Hence, for example, one could see his engines carrying nameplates bearing finely shaped brass letters of the pattern intro-

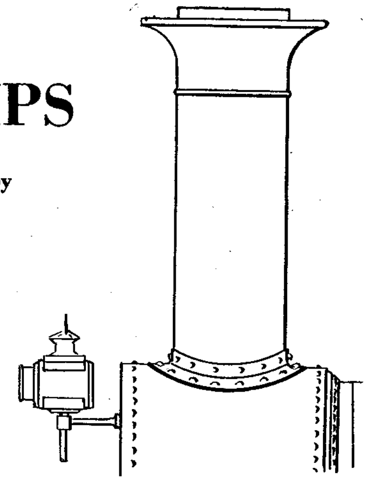


Fig. 1.

duced on the historic "North Star" in 1837, and, be it added, still displayed on the "Castles" and "Kings" of today. Then again, the splendid copper-capped G.W.R. chimney can trace its ancestry back to the romantic days of Gooch's "Lord of the Isles" of 1851 Great Exhibition fame. So with the headlamps. The Gooch broad-gaugers carried a single lamp only, at the foot of the chimney, the design of which was closely akin to that of the old road Mail-Coach type. Fig. 1 shows such a lamp on Gooch's "Waverley" 2-2-4 express engines. Until 1905 the old form of lamp-bracket, which had been such a familiar feature of the front of the broad-gauge engine's smokeboxes, was retained. The Armstrong headlamp had a square body,

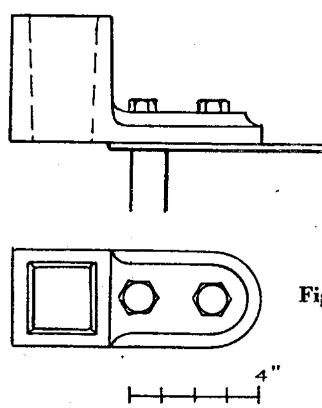


Fig. 3.

4"

a very short handle, semi-circular at the top, and a projecting hood for the lens (Fig. 2). When Dean took charge he remained faithful to the old type, but modified a few details. The lens hood no longer projected beyond the lens itself, and the handles (of which there were two distinct shapes in outline)

* *Continued from page* 346, "*M.E.*," *April* 9, 1942.

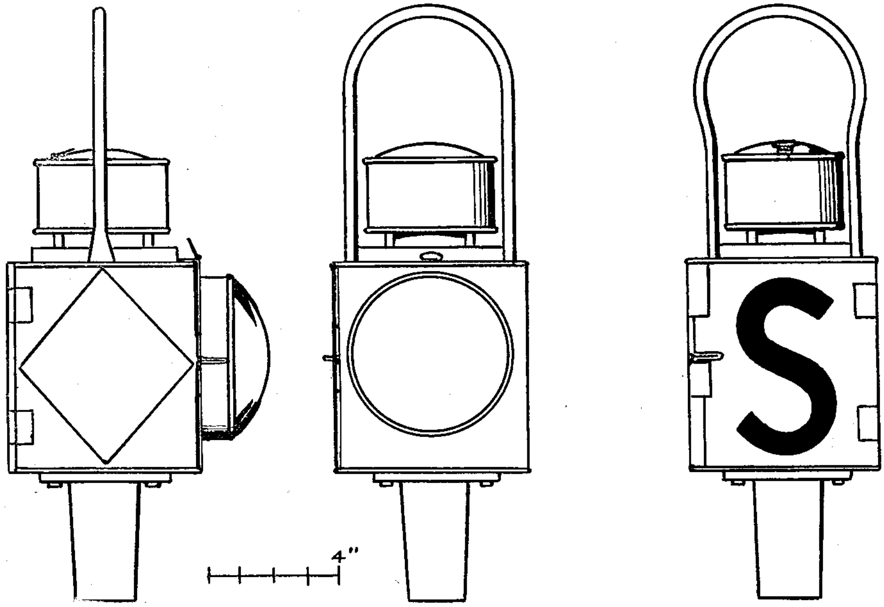


Fig. 4. Fig. 5. Fig. 6.

were very tall. The foot was a long one, and the three lamp sockets, which were attached to the buffer beam, were so placed as to overhang the footplate. (Fig. 3.)

But the feature that distinguished the G.W.R. lamps from all others was the fact that they had to take duty in the daytime as headboards! To serve this purpose they were painted black, and carried a white diamond on the right-hand side, whilst at the back was attached a white enamelled plate bearing a large red letter S.

As the lamp-brackets were square in plan the lamps could be so placed as to present any of their sides to the front as desired. These features are shown in Figs. 4, 5 and 6. That this was an economical method of providing headboards cannot be questioned, but as the average board of the day measured 1 ft. 3 in. in diameter, and the lampsides were only 6½ in. by 6 in., one feels that their visibility when on "day turns" could hardly have been up to existing standards!

True, when on express passenger train working, engines carried only one lamp, and that facing the customary way with the lens looking forward, but many a goods train and "special" displayed the white diamonds and red S. The lamp-bracket at the top of the smokebox, which carried the lamp of the express-train code just referred to, is shown in Fig. 7, from which it will be noted that the bracket also did duty as a handrail support in a similar fashion to that of the L.N.W.R. engines, which has already been described in these pages. The roof of the Dean lamp was hinged, and could be pulled open by a little circular wire handle for cleaning purposes. When not in use, lamps were stored on the footplate, generally between the driving wheel splasher and the cab, on the left-hand or fireman's side of the engine. (Fig. 8.)

Fig. 7.

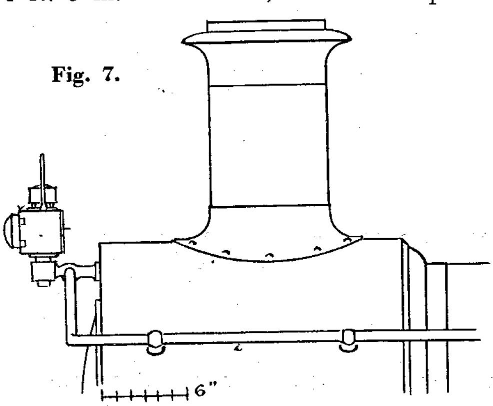
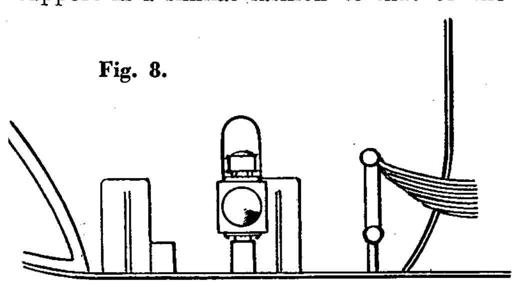


Fig. 8.



(To be continued)

*Mr. J. W. Pattison

Designs a Lathe —

and Suggests some Gadgets for it

DUE to the exceptional length of the front slide, the rear of this saddle is not called upon to take any of the side thrust occasioned in use; therefore, binding and chatter should not occur. Long cross-traverse was required to provide for milling long lengths at one setting. A small table did not provide facilities for holding long work and traversing past the mandrel, with a full length bearing all the way, hence the adoption of an extremely long table. Almost 12 in. of traverse can be obtained with full bearing all the way, and to attain this, the angle of the slides would have to be reversed so as to retain a reasonable sized gib strip. For normal turning, this slide would be well back out of the way, and would not appear to have any disadvantage, therefore.

Another necessity is some form of rising movement to bring the work to centre height and put on cuts. To achieve this, the saddle has a false base and that part containing the slide can be raised by hand-wheel and securely locked at the rear, to form a variable triangle with the bed. The bearings which form the axis of this rising and falling movement are $\frac{7}{8}$ in. diameter and are adjustable.

The feed screw has a bearing at both ends and a graduated dial at the front end, which can be set at zero. This feed screw can be instantly disengaged from its gunmetal nut by giving a few turns to the set-screw, set in the right-hand side of the saddle. By releasing this nut, and with a piece of 1 in. diameter rod bolted vertically on top of the table, to engage a corresponding hole provided in the saddle of the auxiliary bed: then if this latter is set to a predetermined angle, the tool will follow this angle in taper turning. Another addition to the slide rest which would be useful when milling would be an adjustable stop. Though not shown in the drawing, its fitting should be obvious to anyone.

The Apron

Simplicity is in evidence here, as no provision is made for automatic feed, except that normally obtained by change-wheels and the leadscrew. Rack-and-pinion is added for quick traverse along the bed and is assisted by a large hand-wheel. Two half-nuts, each 3 in. long, are used to engage the leadscrew, but they are mounted on rockers instead of slides. Although this does not give a true up and down movement, the error is so slight, and the advantages so great, that it was adopted. The difficulty here was to get a long bearing surface, and as the lead-screw was to be tucked away well up underneath the front shear of the bed, long slides were impracticable, due to the height available; thus, rockers with long shafts appeared to be a much better arrangement. Engagement would be facilitated by the adoption of an Acme threaded leadscrew. A projection cast flush with the forward edge of the apron engages the automatic trips.

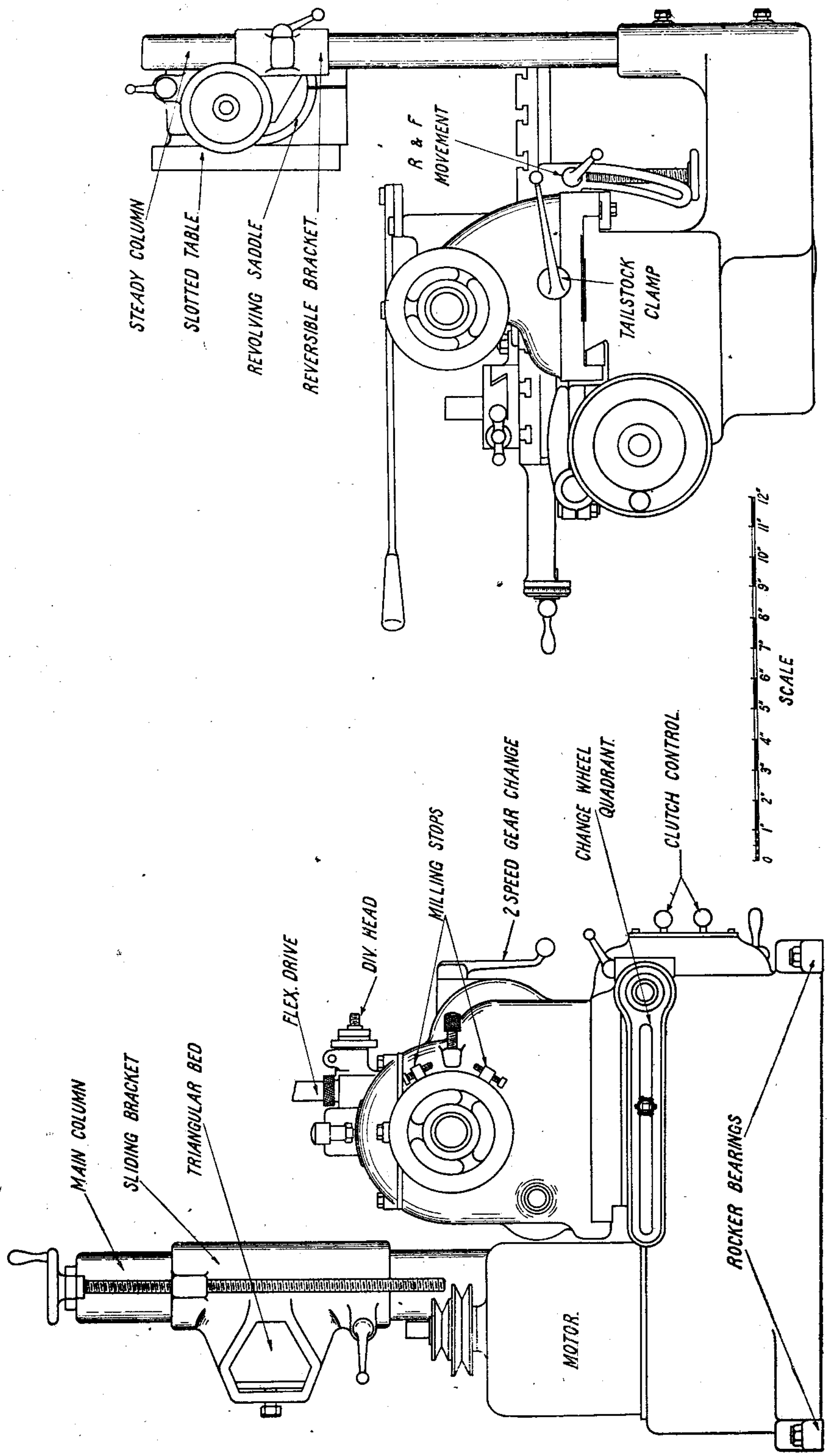
The Leadscrew

This is substantial, being $\frac{7}{8}$ in. diameter, and has an Acme thread, 8 per inch. The adoption of 8 t.p.i. is open to criticism, but it nevertheless has many advantages. All thrust is taken at the headstock end, where the plain portion runs in a bronze bush and has an adjustable thrust-washer. The drive can be put in and out of engagement by a dog clutch, operated by a small knob at the front which has a snap action so that it remains positively in or out. The shaft on which this knob is carried is extended along the bed, and thus can be set to operate automatically. The main purpose of this clutch is to have the leadscrew entirely free from the gear train so that it can be operated manually by the graduated wheel at its far end without dismantling the gear train. The single-toothed dog clutch in the headstock, which works at the beginning of the screwcutting train, also has its control brought to the front of the lathe and operated similarly. The more normal method of screwcutting could be used by disregarding this last clutch and fitting an indicator at the end of the saddle apron. Either method, however, requires only a simple fitment.

The Gear Train

This is a standard arrangement whereby loose change-wheels are mounted on a quadrant. A single slot is all that is required,

* *Continued from page* 378, "*M.E.*," *April* 16, 1942.

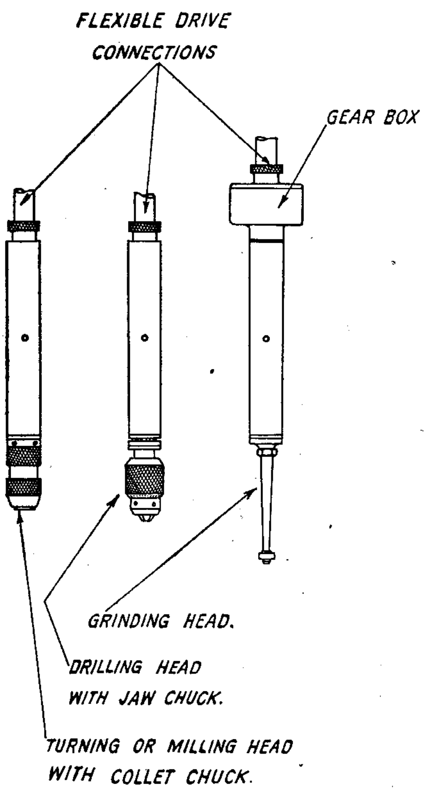


Two end views : Left, headstock ; Right, tailstock of the self-contained universal model engineer's lathe.

due to the long length of the quadrant. It might be advantageous to have the studs milled to slide in this slot, to prevent the tendency to revolve when being tightened up. Splined sleeves are suggested, and a square-holed washer and knurled-headed screw would appear to be as good a method as any other, to secure the wheels. A ball-handled screw is used to lock the quadrant.

Gadgets

The "third hand" arrangement, previously referred to, could take the form of



Drilling, milling and grinding heads adopted for universal mounting on the lathe.

an auxiliary bed mounted at the rear of the lathe and normally parallel to it.

A truncated triangular bar is suggested, clamped in a suitable bracket and mounted on a substantial vertical column, the latter being rigidly fixed to the main bed casting. A similar column fixed at the tail end of the bed would act as a steady, keeping the auxiliary bed normally parallel with the lathe bed, yet allowing it to be set to any angle and clamped in position. Clamping would be affected by a locking bolt on the main column, assisted by a radius-rod extending from the remote end of the bed to the other column. A screw and hand-wheel are provided to assist in raising and lowering the bed on the column. On this triangular bed slides a saddle, traversed by another screw and hand-wheel. The outer part of the saddle is capable of moving around its base and can be clamped in position. It has a 1-in. diameter hole bored in it to take any of the other accessories, including a slotted table. Work may be bolted to this table, or, alternatively, a tool may be mounted here. It does not require much imagination to realise the amount of work that could be accomplished by the aid of the flexible drive and with work mounted in full view.

Little need be said of the flexible drive, as it simply consists of a $\frac{3}{8}$-in. diameter multi-stranded steel wire core, enclosed in an outer flexible casing which is oil tight, and having suitable solid splined ends to take up the drive.

Drilling, Milling and Grinding Heads

Three heads for attachment to this drive are shown in the drawings, one geared for internal grinding, as this requires an extremely high rate of revolutions; another for general work, such as drilling up to $\frac{1}{2}$ in. capacity, and yet another, this time fitted with collet chucks, to be used for fine turning or to carry small milling cutters. All are 1 in. outside diameter and their mounting is almost universal. Like the other gadgets, they will fit into the auxiliary saddle, the collet chuck in head or tailstock, or the universal milling and drilling attachment. Hand drilling, sanding, buffing, polishing, etc., can be done, either on the lathe or at a limited distance from it.

A Metal-cutting Jig-saw

Another gadget is the drill-arm which has a lever feed, the lever remaining out of the way when the arm is used for other purposes. A further gadget, fitting into this arm is the upper half of a metal-cutting jig-saw, where it is secured by a set-screw. Adjustable tension on the saw blade can easily be obtained by raising or lowering the auxiliary bed. This head contains the spring which preserves the tension on the saw blade during its return stroke. It also has a plunger which provides a blast of air at the point of sawing, thus keeping the work clear of cuttings. An adjustable rod, carrying a spring foot and roller saw guide, is inserted in the bracket, immediately alongside the head.

(To be continued)

★ Mr. H. H. Ward's Solution to

The Division-Plate Problem

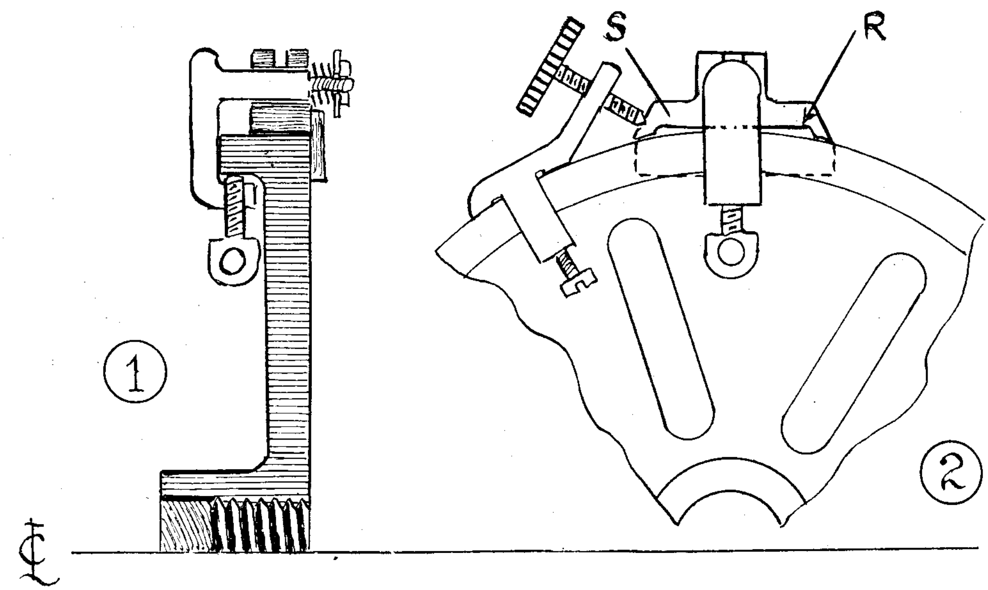
THE advantage of the solution given below lies in the fact that it can be carried out on a plain lathe, as it consists of taking the circumference of the lathe face-plate and dividing it accurately into seventeen aliquot parts so that the face-plate becomes the master plate on which to make the one required. Actually, there are numerous practical difficulties in doing this. Few model engineers possess a micrometer of sufficient size to measure a face-plate, and could not make accurate measurements on a circular arc even if the exact length of the circumference was known. The arc problem can be reduced to a straight line problem by reference to a "Table of Chords", where we find that the factor for seventeen divisions is 0.1838, which means that the diameter of the circle to be divided multiplied by 0.1838 is equal to the length of chord which will span one division.

The diameter of the face-plate can be measured with a finely divided rule, read by means of a lens or eyeglass. Modern "Aircraft" rules can be had, divided to hundredths. In any case, the measurement must be on the *high side* if any doubt exists. The face-plate is assumed to be of the form shown in Fig. 1, and the rim is to be true and smooth. A thin coat of copper put on with "bluestone" would probably make the markings plainer.

Having calculated the length of chord from the reading just taken, a snap gauge of sheet metal (Fig. 3) is made with its opening equal to the length of the chord, but here again, if doubt exists, *the error must be on the large side*. The chord marker shown on the edge of the face-plate in Figs. 1 and 2 is now made. It must terminate in edges which are dead square, and these edges must make an almost perfect line contact with the rim of the plate. The screw gadget (also shown) is a refinement intended to make it possible to move the chord marker forward (when lightly clamped) with micrometer-like accuracy, and to hold it more firmly when both clamps are screwed up. A bent scriber honed so that it is capable of making a hairline dead up against an acute edge is indicated in Fig. 4.

The chord marker is first clamped on the rim of the face-plate and a fine scratch is made with the scriber at "R" and at "S", i.e., either end of the marker. The marker is then lightly clamped just over one chord length further round the rim so that the end marked "R" can be advanced until it coincides with the scratch originally made across "S" as viewed through the eyeglass. This process is repeated seventeen times

* *An entry in our recent Division-plate competition.*



Figs. 1 and 2. Sketches showing the "chord marker" on the edge of face-plate.

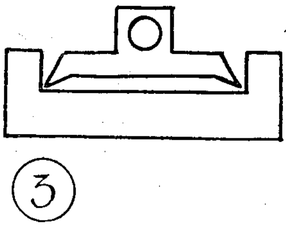


Fig. 3. The snap gauge.

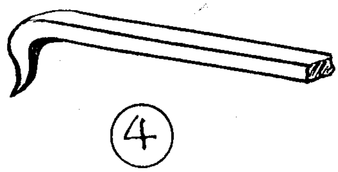


Fig. 4. The bent scriber for making a hairline.

until the marker has gone completely round the rim of the face-plate. As all approximations have been on the *high side, then the chord marker must be too long and the last mark will overshoot the first by an amount equal to the error of the marker multiplied by* 17.

How this error is measured depends on its magnitude. If wide enough, a piece of thin steel can be reduced by filing and honing until it just fits between the two scratches and then its width can be "miked" with a small cheap screw gauge of "school" quality. If too small for this, feelers could be laid on and viewed through the glass. Although the *exact size of the marker* is not known, we do know that it is as big as the gauge we made, and that it is *too big by the amount overshot, divided by* 17. If the error is large enough, feeler blades inserted between the gauge and the marker will give blow on the top, or the face-plate rim could be reduced by a slight rub with fine emery paper cemented to a flat piece of metal.

When the marker reaches the pitch of accuracy required, as found by several trials, the actual plate of $\frac{1}{8}$-in. metal can be mounted on the face-plate by any usual method and the necessary machining can be done. An improvised spring-loaded "stop-pin" device, as indicated in the sketch, is rigged up and the chord marker is started off on a fresh place remote from earlier trial markings. After each fresh setting, the stop-pin is allowed to engage in the hole in the top of the chord marker so as to lock the plate whilst that particular hole is drilled. The actual drilling would be done with a drill spindle, if available, or one might clamp a hardened jig bush in the hand or slide rest and drill through it with a hand drill, using *a straight-fluted drill.*

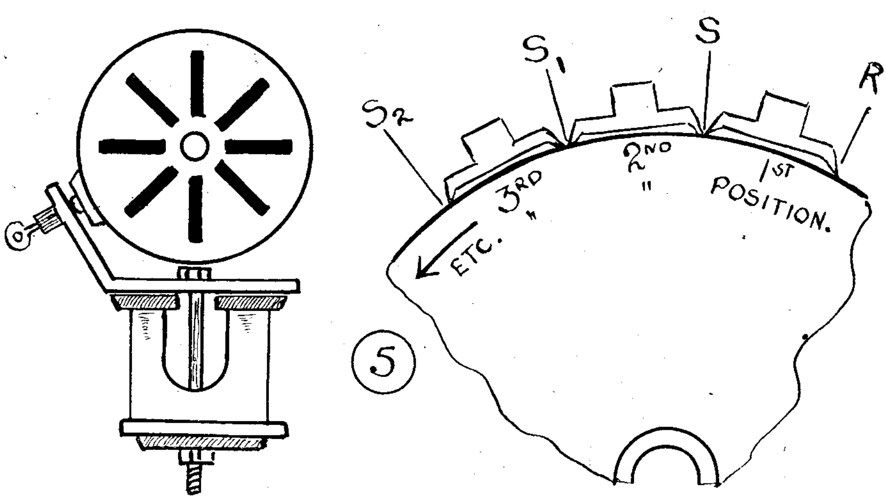


Fig. 5. Marking the 17 divisions.

a guide as to the amount to be taken off, but if the error is within the compass of the "one thou" feeler then a light rub with an India Slip will probably remove sufficient metal. If, by accident, the chord marker is made a trifle too small, it could be laid on a metal block and be "spread" slightly by a

The degree of accuracy obtained will depend on the patience and skill, and to some extent on the eyesight of the operator. The use of a "watchmaker's eyeglass" of fairly high magnification is a great help, and it is surprising how rarely one finds one in the kit of a model engineer.

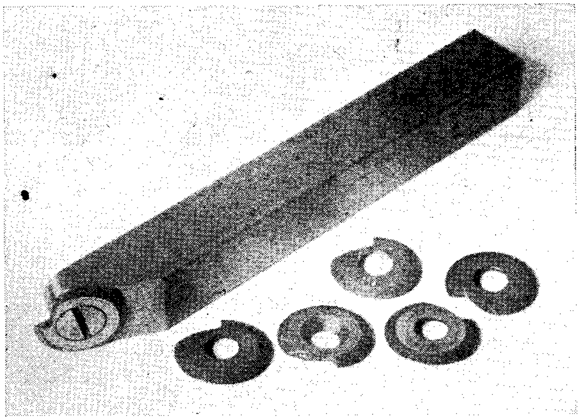
"NED" describes the making of

DISC SCREWCUTTING TOOLS

THE use of circular cutters for forming and screwcutting is quite common in capstan and automatic lathe practice, and has also been applied on centre lathes to a certain extent, though not, in the writer's opinion, to the extent it deserves. Its advantages are obvious, as the correct form of the cutting edge can be maintained throughout the working life of the tool, without being affected by regrinding, while the life is long, because almost the whole circumference of the disc is available for progressive use. Some excellent examples of disc tools are, or have been, available in ready-made form, but quite apart from the difficulty of obtaining anything in the way of special tools nowadays, the standard form of tool is often less suitable for model engineering purposes than might be desired.

Speaking from experience with a well-known disc screwcutting tool of American manufacture, it was found that the shank was too large to be accommodated properly in the tool-post of a 3-in. lathe, and it was only possible to set the tool point to centre height by turning it into a position which gave excessive front clearance, and little or no top rake. The thickness of the cutter was also excessive for any threads of finer pitch than about 12 t.p.i., and it was impossible to work close up to a shoulder, owing to the thickness of the cutter, and the means adopted for clamping it to the shank. It is quite probable that these features might not constitute any serious disadvantage in the majority of tool-room or "full-size" engine lathe work, but they were very troublesome when dealing with the small jobs and fine threads normally encountered in model engineering.

It was therefore decided to make up some disc cutters, together with holders for both internal and external screwcutting, of a size and type more suitable for model work. These proved to be quite simple and straightforward to make, and the results obtained were so successful that it has been thought worth while to describe them for the benefit of other readers.



The toolholder for external screwcutting, and some spare cutters.

Making the Cutters

To consider the production of the cutter discs first, it may be mentioned that there is no essential difference in the discs used for external and internal work, except in the grinding and, possibly, in the size of the latter, which may, of course, have to be limited in case they are required to work in small diameter holes. There is no such limitation in the size of the external cutters; the larger they are, within reason, the better, as they provide more wearing material. It will, however, be found in most cases that a very large disc cutter is inconvenient to accommodate in a small lathe, and it also requires more secure fixing than a small cutter, owing to the greater leverage applied to it by the cutting thrust. Many readers will have difficulty, also, in obtaining suitable tool steel for making large diameter cutters.

In the particular case under discussion, the discs were turned from $\frac{5}{8}$-in. diameter silver-steel to the shape and size shown in Fig. 1, and this size proved to be quite suitable for use as external cutters, besides covering most requirements for internal work as well. Any kind of tool steel, in an annealed condition, could be used instead of silver-steel, so long as the appropriate methods of hardening and tempering for the particular steel are subsequently employed. The cutters may conveniently be machined up in batches, as a spare cutter or two will always be found handy; it is also a good policy to make up a set of cutters varying in thickness, and having different nose radii, for cutting threads of different pitch.

A sufficient length of steel to make up about half-a-dozen cutters at one setting was held in the four-jaw chuck, running fairly truly so as to avoid unnecessary wastage of material. A number of deep grooves were made in this with a parting-tool, leaving " lands " of the width required for the cutters (see Fig. 2), and the latter were then roughly shaped by means of an ordinary solid vee screwcutting tool to within a few thousandths of an inch of finished size. The end of the stock, which

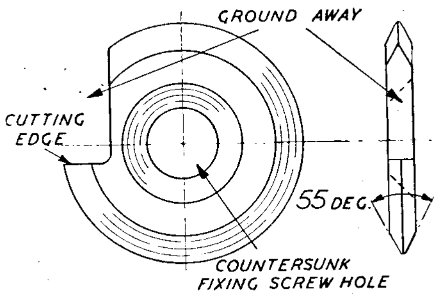


Fig. 1. Form of disc cutter recommended for model engineering purposes. (Twice full size.)

was, of course, truly faced before shaping the cutters, was then centred and drilled concentrically with a 3/16-in. drill, to a depth sufficient to pass through all the cutters being turned. This hole was very carefully countersunk, deep enough to enable the screw which will be used for fixing to be sunk at least dead flush with the surface. It is most important that the angle of the countersink should exactly correspond with that of the screw head, and that the surface should be smooth, and free from burrs or chatter marks.

The next operation consists of finishing the vee edges of the cutter, which is done by setting the top slide over at an angle of 27½ deg. to the cross plane (for Whitworth form threads), and using a side-cutting tool of the appropriate " hand." All the cutter blanks can be dealt with on one side flank first, before re-setting the slide for machining the other flank. The tool used in each case should be oilstoned to a keen and smooth edge, so that it produces a high finish on the work. It is not an easy matter to finish a hard material like tool steel nicely " straight off the tool," but it can be done with care and patience, together with correct tool setting. It is not desirable to attempt to make up for the deficiencies of tool finish by the use of file and emery cloth, but it is permissible to use a fine India oilstone slip to produce a final finish, so long as care is taken not to round off or alter the angle of the edges. When finished, the flanks should bear inspection through a fairly powerful magnifying lens such as a watchmaker's ocular; this will show up any minute scratches or roughness which would be liable to interfere with the efficiency or smooth working of the finished cutters. The tip of the vee is then rounded off very slightly with the oilstone; in the event of cutters made to suit various pitches, the radii of the respective tips should also be made to suit. A standard thread pitch gauge can be used as a form template, viewing against a light or a reflector placed at the back of the work, and with the aid of the lens.

It will be found that the exercise of these rather elaborate precautions to ensure correct form and finish of the cutters will be amply repaid by the ease with which accurate and well finished threads can be produced with them eventually.

The end cutter may now be parted off with a keen parting-tool, using plenty of lubricant, so as to produce as fine a finish as possible. It may be found advisable to support the work with the back centre during this operation, to avoid spring or chatter. When the first disc has been separated, it may be found necessary or desirable to take a light facing skim over the end face of the next disc, after which it is countersunk, and parted off in the same manner as before; all the discs are subsequently treated in the same way. The surface left by the parting-tool on the back of each disc should be cleaned up by rubbing

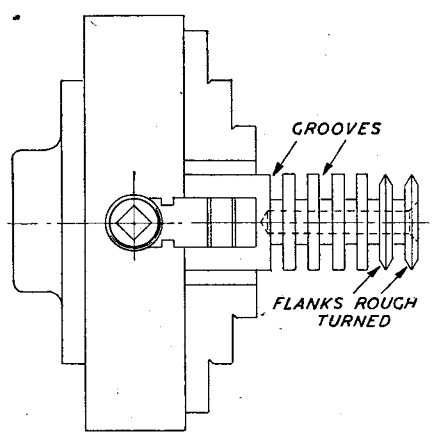


Fig. 2. A batch of cutter discs in course of machining. (Not to scale.)

on a sheet of emery cloth, and the burr round the centre hole carefully removed.

Hardening and Tempering

It is advisable to string the batch of discs together on a mild steel bolt for this

operation, as this not only simplifies handling, but also helps to ensure that they are uniformly heated. If the cutters are dealt with singly it is very difficult to ensure that they all attain the same temperature. Assuming that they are made from carbon- or silver-steel, care should be taken not to overheat the thin tips, and for this reason, some method of heating which avoids a direct flame impinging on the discs, such as a small gas muffle or electric furnace, is very much to be recommended.

For quenching out, cold water with a layer of thin oil about ½ in. thick floating on it has been found very effective for securing the requisite hardness, and at the same time avoiding the formation of water cracks. The bolt with the pack of discs on it is held vertically in a pair of tongs and plunged into the centre of the quenching vessel, then stirred round until the cooling is complete. By this means even cooling is ensured, and the trapping of water or steam in the interstices of the discs is prevented.

The discs are now taken off the bolt and mounted individually on a mandrel for polishing all over with fine emery cloth. They should be kept dry and free from oil, and should be handled as little as possible at this stage. Tempering may then be carried out by laying each disc in turn on a piece of asbestos and inserting in the centre hole a conical rod heated almost red hot. The "temper" colours will run from the centre outwards, and are under good control; as soon as the flanks of the disc arrive at the correct temper the hot rod is removed, and the disc quickly quenched out again in clean cold water. It is best to let the temper down slightly more than is usual for ordinary lathe tools, as the extreme tip of the tool takes very heavy loading, and is liable to chip badly if it is too hard.

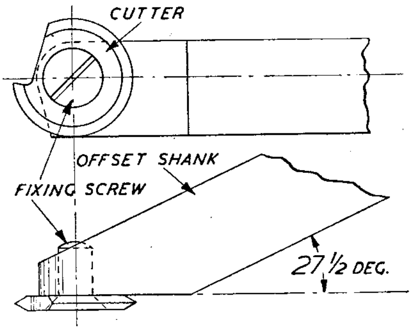
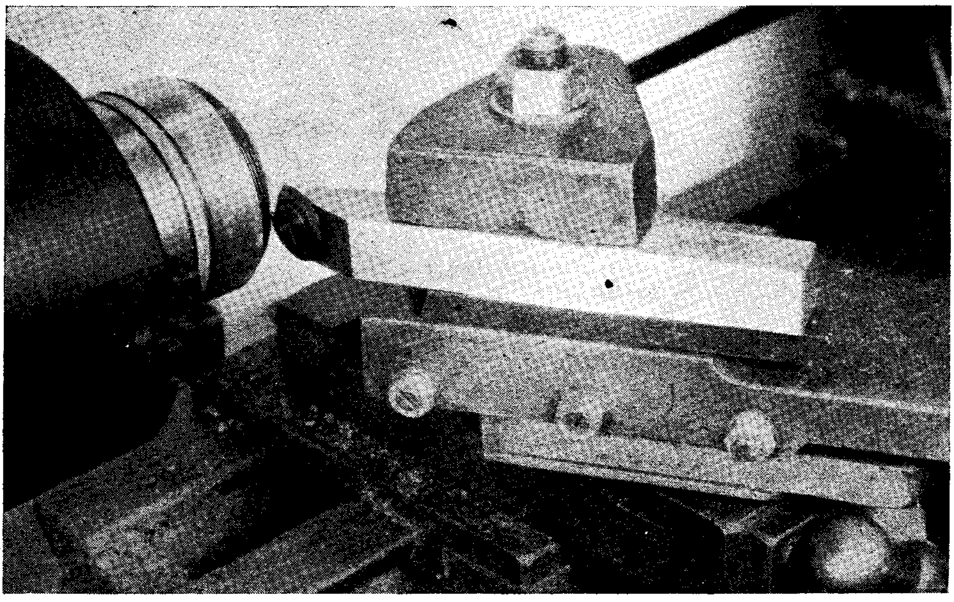


Fig. 3. Offset toolholder for external screw-cutting. (Full size.)

The flanks of the vee should reach a dark straw colour before quenching; silver-steel will stand a rather greater hardness than most ordinary forms of carbon tool steel, without becoming unduly brittle, but even so, it should be let down to at least medium straw colour at the outer edge.

In the event of high-speed steel being used, the directions furnished by the makers for hardening and tempering it should be carefully followed.



Cutting a fine thread (36 t.p.i.) on a lens cell for an optical instrument. (Note the way the top slide is set over to correspond with the flank angle of thread.)

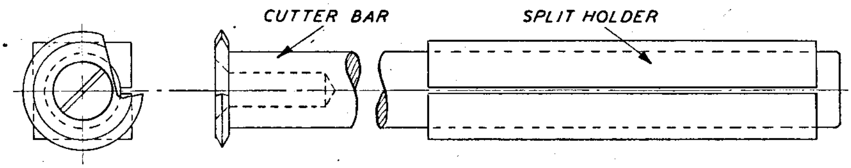


Fig. 4. Holder for internal screwcutting. (Full size.)

Grinding

When grinding the notch in the cutter, great care must be taken not to overheat it and draw the temper. Few model engineers, it is presumed, will have access to a grinder equipped with water service for keeping the work cool, and in the absence of this provision, the only thing to do is to proceed cautiously, and cool off the disc in water as soon as it becomes uncomfortable to handle with the bare fingers. It might be thought that time and trouble would be saved in grinding by *filing* the notch in the cutter before it is hardened; but it has been found by experience that the presence of this notch while hardening and tempering is liable to lead to irregularities in the temperature flow, and thus make it difficult to ensure perfectly even hardness all round the cutter. These difficulties are not insuperable, perhaps, and they have to be faced in the case of milling cutters, and similar tools, but it is best to avoid them if possible.

With the ordinary tool grinder, it is impossible to form the notch to an angle more acute than 90 deg., unless the wheel is specially dressed to shape; it is thus necessary to take away nearly a quarter of the circumference in the initial grinding. Most grinding wheels will normally have a slight radius on the corner, which will produce a fillet in the corner of the notch; this is desirable, to avoid undue weakening of the disc at this point. If the side of the notch is ground exactly to the radial line, the cutting edge will have no top rake; in fact, if the tool is set as recommended, the rake will be negative. It is thus advisable to grind this edge well past the radial line, so as to produce an undercut.

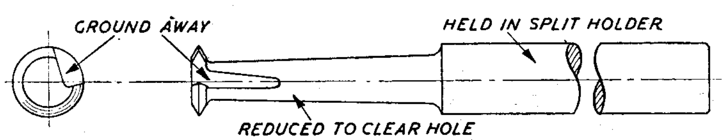


Fig. 5. Form of tool recommended for small internal screwcutting.

Holder for External Screwcutting

This is simply a piece of ½-in. square mild steel bar about 3½ in. to 4 in. total length, with the end suitably shaped for the mounting of the disc as shown in Fig. 3. It may be left quite straight if desired, and the disc simply attached to the side, but the "offset" form of holder shown will be found much more handy to use, especially when working close up to the chuck jaws or other obstructions.

The side of the bar is bevelled off at an angle of 27½ deg., for a reason which will be apparent later, and the end face rounded off at the top and sloped away below to provide clearance. It will be seen that the disc is attached to the bar by a single 2 B.A. countersunk screw, and this feature may be strongly criticised as insecure—indeed, a good deal of comment has already been encountered on this point from people who have seen the tool. The answer, however, is that, provided the contact faces of the disc and its holder are truly flat, and the screw head fits the countersink properly, sufficient friction grip is provided to hold the disc rigid against all normal cutting strains; this is not conjecture, but ascertained in actual practice. If the tool point should be overloaded, it is obviously better that the disc should slip than that it should break.

The clamping face of the holder is square with the top face of the bar, which is satisfactory for general work, cutting both right- and left-hand threads of fine or moderate pitch angle. If only right-hand threads are to be cut, there would be some advantage in sloping this face slightly to provide better clearance, but the most suitable angle cannot be predetermined unless all threads to be cut have the same pitch angle—a condition which seldom, if ever, obtains in actual practice.

In order to obtain front clearance with this form of cutter, it is necessary to set the cutting edge slightly below the centre of the securing bolt, as shown. This does not mean below lathe centre height, however, so the bolt must be a corresponding distance *above* the latter position. The size of stock, and the position of the screw, may be chosen so that it suits the particular lathe in which the tool is used, avoiding the necessity

for packing or other height adjustment.

The tool point should be only slightly below the disc centre, because otherwise the angular form of the thread will be affected to a greater or less extent. In the case of the ⅝-in. dia. cutter, it was found that good results were obtained by setting the point 1/32 in. below centre. This position, it will be found, also avoids digging in, as any slip or spring of the tool point relieves the cut.

Setting of the tool, to ensure that the vee angle is square with the axis of the thread, is extremely simple and does not require the use of a gauge. It is only necessary to run the slide rest up close to either the driver plate or the chuck face, according to which is in use at the time, and set the side of the disc in contact or exactly parallel with it before clamping down.

Many turners like to follow the very sound practice of feeding the tool in at an angle corresponding to one side of the vee thread, thus taking the cut on the leading side of the tool and relieving the load on the extreme point. To set up the tool for this method of feeding, the shank should be disposed exactly parallel with the ways of the top slide before clamping in the tool post. The slide is then swivelled until the disc face is square with the lathe axis, using the method of testing above described. In this way, the necessity of using a protractor to set the angle of the top slide will be avoided—assuming, of course, that the offset face of the holder has been correctly shaped to the specified angle of 27½ deg. When cutting threads in steel by this method, the cutter should be ground with a side slope, to produce side rake on the leading edge.

Holder for Internal Screwcutting

Many model engineers use the popular form of boring tool which comprises a round tool or cutter-bar held in a split holder. To adapt this device for holding disc screwcutting tools it is only necessary to provide a mild steel bar of suitable diameter to fit the clamp, with the end truly faced, drilled and tapped to take the screw which secures the disc, as shown in Fig. 4. Other forms of holders which will take round-shank tools are equally adaptable; or, if desired, the disc may be attached to a solid shank formed by turning down the end of a square bar. As previously mentioned, it may be desirable to use smaller diameter discs when screwcutting small holes, but for work of this nature it will often be found best to turn the vee-pointed disc on the end of a small diameter tool steel bar, reducing the portion behind the cutting edge for a sufficient length to clear the depth of hole to be dealt with. The edge is notched as before, and the bar is held directly in the split clamp. (Fig. 5.)

The time spent in making simple tools of this nature will be amply compensated by that saved in using them, to say nothing of the improved quality of workmanship which they make possible.

Producing a Crystallised Black Finish

CRYSTALLISED black finish can be effectively produced on model parts, optical instruments, etc., either by spraying or hand brushing. The thickness of coat applied has a considerable bearing upon the final finish obtained; thus, a thin coat will give a dull finish with a fine crystal pattern, while a fairly heavy coat will give a glossy finish with a large pattern.

To secure proper adhesion of the lacquer or enamel coating, make sure the model parts are perfectly clean and dry. After applying the enamel, place the parts in an oven or other suitable appliance and heat for one hour at a temperature ranging between 140 deg. and 170 deg. F., and in order that the enamel will crystallise.

The heating appliance should be of the foul type, that is to say, the products of combustion must be allowed to come into contact with the work, and the ventilation should be controlled to keep the products of combustion in the heating appliance at a high production. Gas heat seems to be essential to good results, the theory being that the gas flame burns out the oxygen in the appliance and leaves a neutral atmosphere.

Another good finish for model parts, etc., which has an attractive effect, is the modern cracking enamels. These materials are entirely air drying and their application needs little skill. The process is, briefly, as follows: (1) The model parts are given a coat of special primer, and sand-papered smooth. (2) A base coat of any desired colour is then applied by spray; drying time 30 to 60 minutes. (3) A full coat of cracking enamel is sprayed on; drying time 10 to 15 minutes. As this enamel dries it splits up spontaneously and shows a myriad of cracks, through which the base coat colour is revealed. The size of the cracks formed is largely governed by the coating applied, a heavy coating causing large cracks to appear, and a light coat forming only small cracks. Specimens may be obtained from the I.B.I. (Paints) Ltd., Alma Street, Smethwick, Birmingham.—A. J. T. E.

BELTS and BELT FASTENERS

for the Home Workshop

By G. E. COUPLAND

A HORSE and cart without harness would not be much use, and the best home workshop machinery would lie idle without the necessary belting to put it in motion.

In much of what follows I shall, no doubt, appear to old experienced hands to be labouring the obvious, and I would therefore ask their indulgence in the interests of the less informed youngsters and novices to whom my remarks are mainly addressed.

The belt, though a trivial thing in itself, is really a very important link in the chain of forces which we employ in our home workshops, and is, I think, worthy of more consideration than is usually bestowed upon it, which is my excuse for the present plea. The modern machine tool with separate built-in electric motor, doing away with shafting and belts need not concern us, and is, in any case, outside the scope of the present article and the competence of the writer.

I am confining my remarks to *leather* belts, as I believe them to be the best suited to the home workshop and the most generally used. Fabricated belts, such as "Balata," cotton, canvas, rubber, etc., are much used in large factories and commercial undertakings, where working on large pulleys with long drives they may have some advantages, including lower first cost, but for the home workshop with its small pulleys and short drives "there's nothing like leather," as an old cobbler once remarked. In my time I have tried different kinds of both flat and round belts, but now stick to leather.

Commercial leather belting is, in my experience, usually intended to transmit far more power than the average amateur has at his disposal and absorbs a not inconsiderable proportion of valuable power which might otherwise be available at the tool point. It is generally too thick for its width, is too stiff and inflexible, particularly if it contains cemented and sewn long lapped joints. These joints are unavoidable if the belt is a long one, because the animal which furnishes the hide to make the leather cannot oblige by growing a hide longer than his own body. These joints are often somewhat thicker than the remainder of the belt and will not bend readily round small pulleys unless stretched unduly tight, which absorbs power and imposes an unnecessary strain on shafts and wears on bearings. It always seems to me to be intended to work on pulleys of a minimum diam. of about nine or ten inches and in such circumstances is, no doubt, quite efficient.

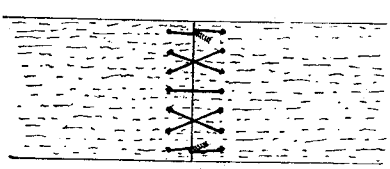


Fig. 1. Permanent butt joint in flat belt.

The amateur mechanic who has to rely on treadle gear or perhaps a ¼-h.p. electric motor, requires something different. In my workshop I use one ¾-in. and two 1-in. flat leather belts and four round leather belts of different thicknesses. My largest pulleys are about 6 in. diam. and the smallest for flat belt only 1 in. and for round belt only ¾ in. diam. The belts run only moderately tight and yet I am never troubled with belt slip, even on the smallest pulleys.

In the case of the lathe which is driven by a 5/16-in. round leather belt from a cone pulley on overhead shaft, I purposely allow the belt to run slack enough to slip in the case of a bad "dig-in" or other unexpected obstruction, as a slipping belt is much preferable to a broken tool, spoilt work or other mishap to the lathe. So long as the belt is tight enough to overcome the resistance between work and tool on the largest diam. and heaviest cut likely to be used, nothing more is required and any further tightening of the belt is only taking unnecessary risks and inviting trouble. "Safety first!"

In the case of lathe work, it is really surprising what a lot of difference a keen, correctly ground and properly applied tool makes to the amount of power required to drive the lathe. Users of foot power will know this from experience.

I have vivid recollections of a man who was once showing me his lathe: He was using solid forged tools. I glanced at the cutting edges and got a big shock. The tool I saw was very blunt, the cutting angles wrong and facets which should have been flat were badly rounded. How on earth he managed to scrape anything off the workpiece, I don't know, and the surface left by the tool can be better imagined than described. For power he was using an I.C. engine, whether gas or petrol I can't remember, which, judging from its size,

appeared to be 2 or 3 h.p. He was evidently a firm believer in brute force rather than correct scientific principles. He was an older man than myself, so I maintained a discreet silence, but thought a lot.

The amount of power a given belt will transmit depends almost entirely on its linear speed, so belts should be run as fast as conditions permit, any reduction of speed at the final point being obtained by gearing or chain transmission following the belt. The back gear of the lathe is a good example.

Flat Belts

Dealing first with flat belts, if the home mechanic is unable to obtain belting not thicker than about $\frac{1}{8}$ in., I advise planing it down to about that thickness to make it suitable for pulleys up to approximately 6 in. diam., and if the belting contains lapped joints, it is advisable to cut these out and substitute butt joints. Leather belting can be very easily planed down to any desired thinness by simply stretching it down on a flat stout board, flesh side uppermost, and taking off the surplus with an ordinary smoothing plane (an all-metal plane is best). The plane " iron " must be razor-sharp.

For making the butt joints I have used different kinds of "lacings," such as "wax-ends " as used by cobblers, fine fishing line, copper wire, etc., but the stuff I use at present is the best I have found, namely 20 or 21 gauge soft iron wire. Fig. 1 shows how the joints are made. First trim off the ends of the belting dead square across with a sharp knife, using an engineer's square, the blade of which forms a guide for the knife; then make a pencil line square across the belt at a distance from the cut end equal to about one-and-a-half times the thickness of the belt. On this line make holes, five for a $\frac{3}{4}$-in, belt, seven for a 1-in. belt, nine for $1\frac{1}{4}$-in., and so on. The holes should be made with a fine awl. (I use a gramophone needle held in a hand " pin " chuck.) The holes can be spaced near enough by eye.

Make a hole in the middle of the width first, then holes near each edge, half belt thickness from edge, then fill in intermediate holes. Bend the wire into the shape of a hairpin and push the ends through the middle hole of each piece of belting being joined, pull tight and press the wire well into the leather, cross the ends of the wire on the other side of the belt and return through the next pair of holes, pull tight again and press in, cross again and push through the next pair of holes. Twist the ends of wire emerging from the last pair of holes at the edge of the belt together, bend over the twisted part, after cutting off the surplus, and tap down with a hammer. Do the other half of the belt in the same way, commencing from the underside. One piece of wire can, of course, be used, commencing at one edge and finishing at the other, but I prefer to use two pieces, as the ends to be threaded through are not so long, and it is easier to keep the belt ends in line and the stitches of even tension.

For " enclosed " pulleys, i.e. those between shaft bearings, it is convenient to have some

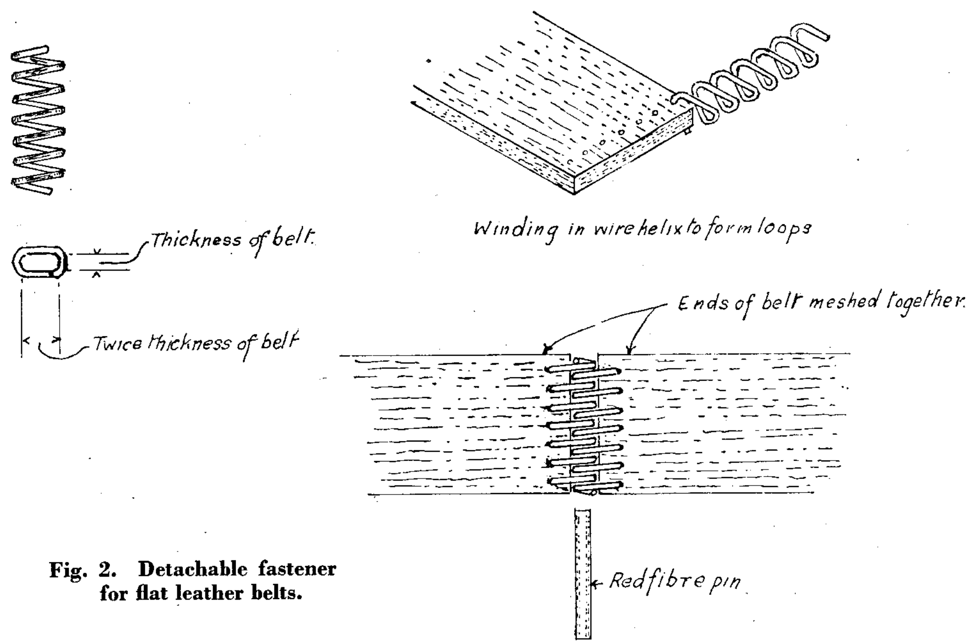


Fig. 2. Detachable fastener for flat leather belts.

means of easily and quickly joining up and dis-joining the belt, so as to permit of taking it right away when not needed, instead of allowing it to ride on the shaft—always a risky and dangerous practice—and for shortening to take up slack. There are a number of fasteners for flat belts on the market, all more or less, in my opinion, clumsy and noisy when working over small pulleys, and some even necessitate the ends of the belt being turned up at right-angles on the outside, and a huge hole in the belt.

Being dissatisfied with all available types, some years ago I invented my own fastener, which has proved ideal in use. It can be made at home from the simplest materials in a few minutes, is strong, practically indestructible and will run over the smallest pulleys without shock and hardly any noise, and the break in continuity of contact is practically non-existent. It is perfectly flexible and can be connected and disconnected instantly without tools, and, moreover, possesses the added advantage that the back of the belt will run over a jockey pulley to change its direction equally as well as the other side.

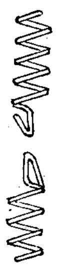


Fig. 3. Detachable fastener for round leather belts.

This fastener is shown in Fig. 2. It consists of two pieces of 18-gauge galvanised iron wire (*not* piano wire) wound on a former like helical springs, but oval in cross section, and a red fibre pin. To make the helices, a simple former is needed; metal is best, but hardwood does very well. The former must have the same thickness as the belt for which the fastener is required, and a width twice that of the belt thickness. If the former is of wood, simply rub off the corners with glass-paper. Grip the former in the vice projecting horizontally and close-wind the wire on, anti-clockwise, commencing close to the vice jaws, five turns for a ¾-in. belt, seven for a 1-in. belt and so on, with a turn or two over for convenience in handling. Remove the former and pull out the turns with the fingers to the same spacing as the holes in the belt, which holes should be made in a line square across the belt exactly the belt thickness from the cut end. The wire will then have the appearance of a flattened corkscrew, as shown in the left-hand view, Fig. 2.

Don't attempt to wind the wire on a round former and squeeze oval afterwards. This would only result in the coils slipping over sideways, lying partly on the top of each other like the bank clerk's tipped-over stack of pennies. Wind the helix through each hole in succession, corkscrew fashion, guiding the leading end through each hole in succession, commencing as shown in the top view, Fig. 2. Snip off the leading end close to the end of the belt and clinch down. As the wire is comparatively soft, this is easily done with pliers. Snip off any unwanted coils at the finishing end, leaving the end long. Treat the other end of the belt in the same way, then mesh the two ends of the belt together, as shown in the lower view, Fig. 2, and pass a round metal rod, a close fit, through the intermeshed loops and bend the finishing ends round the rod closely, making them into rings. Remove the metal rod and substitute a close-fitting pin the same length as belt width, *made of red vulcanised fibre.*

It is very important that this pin be of red fibre and not metal, as on it depends the successful working and wearing qualities of the fastener. It is not necessary that this pin be perfectly round, in fact, it is better if it is a bit angular in cross section, because the wire loops tend to embed themselves into the little corners when the belt is in tension, which helps to prevent the pin working out. For a ⅛-in. thick belt, simply saw off a piece of fibre about ⅛ in. wide from ⅛-in. sheet and roughly file off the extreme corners.

It might be thought that such a fibre pin would not have the necessary strength, but this is not so in practice. Red fibre offers considerable resistance to shearing, and when it is remembered that the total strain on the pin is equally distributed over a number of points, it will be seen that the pin will stand up to a pull very much greater than it is likely to be subjected to in use. I have had two of these fasteners in use for about three years (not continuously, of course, but the total hours would no doubt add up to hundreds) yet the pins show no sign of wear and have never once worked out endwise.

For some purposes, round belts are better than flat ones, and, indeed, for some drives they are essential. They do not require such accurate lining up and parallelism of the pulleys, and permit the drive to be skewed to a certain extent, which is very convenient for some operations.

I have used various types of fasteners and have found all of them to have certain shortcomings. The double-wire hook, as used on sewing machines, requires large holes through the ends of the belt, which weaken it at these points, especially if the belt is a thin one. In passing over small pulleys, the hook see-saws about in the leather and eventually breaks through at the side of the hole, necessitating making a fresh hole farther along the belt and perhaps rendering it too short. If the hook is clinched down to prevent its working about, the joint is made too stiff and is difficult to unhook.

The commercial hooks and eyes, with internal thread, while quite good for gut bands, are unsuitable for leather. The internal thread is too fine and strips the leather. They also cause a distinct shock in passing over small pulleys and make an irritating clicking noise.

Wire screw hooks and eyes screwed into the ends of the belt are worse still. They make the ends of the belt inflexible and, with continually bending and straightening out, they soon break off and leave a bit of the screw in the end of the belt, which is difficult to remove except by cutting off altogether, making the belt shorter. They also cause a long break in continuity of contact.

In this case also, therefore, I have had to invent my own fastener, which, I believe, has eliminated all these faults, and, at any rate, has proved superior and entirely satisfactory. This is shown in Fig. 3.

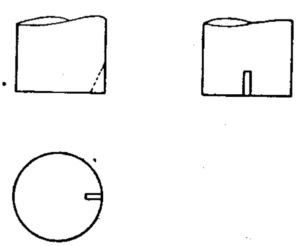
It is made of hard steel wire (so-called piano wire). The essentials are that the coils in the wire must be equally spaced, the internal diam. must exactly suit the diam. of the belt and the gauge of wire used must be suitable for the belt diam. For 5/16-in. and $\frac{1}{4}$-in. belts use 19 gauge; for 3/16-in. 20 gauge and for $\frac{1}{8}$-in. 21 gauge.

To make, choose a long wood screw with shank equal to the diam. of the belt. It may be slightly smaller, but certainly not larger. Cut off the head and grip in the vice, projecting horizontally. Nip the end of the wire between the shank and the vice jaw and wind the wire tightly into the thread of the screw, putting on about six turns. Cut off, leaving a long outer end. Don't use your best cutting pliers for this, unless you want to spoil them. Nick with a three-cornered file and break off. On releasing hold of the wire after winding, the coils will spring back a little, leaving them of the right size for the belt. Remove the screw and cut off the first coil or so, including the bit of wire that has been nipped in the vice. Bend the finishing end up at approximately right-angles to the axis of the helix and form the end on one-half of the fastener into a hook, with round-nosed pliers, and the end of the other half into a closed loop. Bevel the extreme ends of the belt so that they will just enter the end coils, then work the fasteners on like screwing on a nut. With the thicker gauges of wire, it is necessary to hold the belt ends in the vice and turn on the fasteners with "gas" or "pipe" pliers. Don't turn by gripping the hooked ends with flat pliers, as that would open out the coils and spoil the fastener. As the belt emerges from the hooked end, cut off the bevelled part in slices until it is all removed. As the coils travel down the belt they do not actually cut a groove in the leather, but rather sink or press themselves into the leather and cause the leather between the coils to rise or swell slightly. Thus, the fasteners get a very firm hold on the leather, much more secure, in fact, than would be afforded by a screw thread.

These fasteners do not screw themselves off in use, because any tendency to turn in the opposite direction simply causes the coils to grip still more tightly. In fact, they cannot readily be unscrewed by using force with pliers. The tension in use also tends to increase the grip of the fastener on the belt. These fasteners are the best thing I know for round leather belts. They hold tenaciously, flex easily round small pulleys, do not weaken the belt, can be instantly connnected and disconnected, never wear out, and the belt can be shortened to any desired extent by simply screwing the fastener farther on and cutting off the surplus as it comes through. The end coil may spring slightly in use, but this is no detriment, but rather an advantage, as it tends to take up the slack on the non-pulling side of the belt.

Removing Bushes

In the July 10th, 1941, issue of THE MODEL ENGINEER, Mr. L. A. Watson described a method of removing a bush from a blind hole by means of a tap. I don't like this—it damages the bush, and anyway can't be used with a hardened steel bush. Here is a better way:—



Turn up a bit of scrap rod a good (tightish) push fit in the bush; face the end; remove sharp arris with a hand tool. This must be finish *turned* to a fit, no file-and-emery business. File a small groove, or cut with hacksaw, see sketch.

Fill hole in bush and brim with oil, push in toward rod as far as it will go—the oil escapes through groove until the top of groove is below top of bush—then hit it a fairly hard smack with a *heavy* hammer. The oil has to go somewhere, and so the only thing it can do is to push out the bush. The "secret" is a real good turned fit, and a decent weight of hammer, 2 or 3 lb. for a $\frac{1}{2}$-in. bush. Don't make the oil groove too long, just enough to give it a start before hammering, so that it doesn't jam, and be sure no air is trapped beneath the plunger.

It works on the "hydraulic ram" principle, and I have never known it to fail.—C. R. C.

Letters

Pressure-gauge Testing

DEAR SIR,—With reference to Mr. Stuchfield's criticism on the use of oil or other non-compressible medium in pressure-gauge testers, as that gentleman is aware that such testers are commercial articles (*vide* the last paragraph of his letter in THE MODEL ENGINEER for April 2nd), one can only assume that his tester is offered as simpler to make and/or use.

I have used an oil-type tester for some years and never found any "complication in operation." Quite recently six 12 in. gauges were tested to 300 lb., the tester standing on my office table—there was no mess or leakage of oil, and once filled it was not necessary to manipulate the screw plunger—sorry, Mr. Stuchfield, I should have said "pump."

As to manufacture, the "not too easily made pump" is merely a straightforward tap and die job. The ram is plain turning accurately "miked" to size; and note that this is *external diameter*, unlike Mr. Stuchfield's. In his case as he uses an expanding piston, i.e. a cup leather, *the bore of his cylinder must be dead accurate for size.* It should be remembered that if, in practice, leakage is encountered when using a light oil, it is only necessary to use a thicker oil—even the use of a heavy cylinder oil will not affect the accuracy of the machine. Recourse to this method of stopping leakages should be quite unnecessary for the average model engineer.

The Society of Model and Experimental Engineers has had a small size oil-type tester for some years, all the gauges on the locomotives which are run at the "M.E." and Model Railway Club exhibitions being periodically tested. No trouble has been experienced either in its manufacture or its use, and it has the merit of being self-contained and is not susceptible to damage.

Incidentally, even small gauges are sometimes required to record high pressures. Mr. Stuchfield's tester is limited to the pressure that can be produced by his air pump, and it is not every cycle pump which can supply air at 200 lb., which would be required to test a gauge to be worked at 100 lb., it being usual to use a gauge reading to twice its working pressure; the maximum pressure of which any air pump is capable being, of course, a matter of design—(swept volume to unswept or clearance volume)—and not of power supplied, or mechanical condition of the pump.

Model engineering is usually on safe ground when it follows prototype methods and practice, and I suggest that it is so in this case.

Yours faithfully,

London, S.W. W. BARNARD HART.

Clubs

The Society of Model and Experimental Engineers

There will be a Rummage Sale in the Workshop, 20, Nassau Street, London, W.1, on Saturday, 25th April, 1942. All lots should be entered by 2.30 p.m. Owing to the shortage of small tools and materials, there has been some very brisk bidding at recent sales, and it is hoped that members will do their best to exchange any surplus supplies they may have by bringing them to the Workshop on the date mentioned.

Secretary, H. V. STEELE, 14, Ross Road, London, S.E.25.

Sutton District Model Railway and Engineering Club

The Club's financial year ended 31st March, 1942. New members joined during the year, some whose names are prominent in model engineering circles. The outstanding feature of the year has been the completion of main drainage for the Club House at Chatham Close, North Cheam. Owing to the Sutton and Cheam Council cutting a new surface water sewer, it was possible to have the Club's drainage laid at the same time, and the Club is greatly indebted for the co-operation shown by the Council and the officials concerned.

The Club, at the request of Sutton Warship Week Exhibition Committee, placed a selection of models on show, and, in spite of short notice, members made a great effort, with satisfactory results, earning the thanks of the Committee. An illustrated description of our show of models appeared in last week's issue of THE MODEL ENGINEER.

At the Club's monthly meeting on the 5th April, we had the pleasure of a visit by the Honorary Secretary of the Kent Society and a party of members, and it is hoped to extend these inter-club visits in the future, to the mutual benefit of all concerned.

Hon. Sec., P. G. JOHNSTON, 9, Stanley Road, Sutton, Surrey.

NOTICES.

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects. Matter intended for publication should be clearly written, and should invariably bear the sender's name and address.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

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